Three Dimensional Fault Detection Using Dip and Azimuth

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Dip, azimuth and discontinuity such as fault are fundamental paraleters of structural interpretation. We are presenting a method to estimate dip, azimuth and fault continuously in a 3D seismic volume. Spectral decomposition methods provide time-continuous phase spectrum at each trace. Laterally continuous local phase surface at a fixed time indicates a reflector and the surface gradient divided by frequency and averaged over frequency bands of high signal-to-noise ratio gives time-dip and azimuth. In contrast, a discontinuous local time-dip/azimuth indicates a point on a fault, conflicting dips, interference or noise. In our method we take the time-surface misfit error as a measure of discontinuity by fitting a least square plane to spatially continuous local phase surface. Our method does not pick horizons or compute cross-correlations where you fix the phase and track time differences across neighbor traces. Instead we fix the time and compute phase differences across traces. This alternate method to compute dip from phase difference greatly simplifies the detection process.

The time-continuous phase spectrum based dip and azimuth estimation shows exact quantitative match with input parameters in a synthetic model study. This technique provides dip and azimuth in the entire volume without the need for horizon picking. Application of the technique to automatically detect faults in a 3D field seismic volume shows excellent visual comparison with the fault that an interpreter would pick on a seismic section. The detection step uses a high productivity tool. After an interpreter selects detected faults the surface mapping in 3D follows automatically. We show examples of automatic fault detection using 3D seismic volume.